

(19)



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(11)

EP 1 236 671 A1

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:

04.09.2002 Bulletin 2002/36

(51) Int Cl.7: B66B 9/08

(21) Application number: 01200767.0

(22) Date of filing: 01.03.2001

(84) Designated Contracting States:

AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE TR

Designated Extension States:

AL LT LV MK RO SI

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### (54) Driving mechanism for a stairlift

(57) The invention concerns a staircase lift for transporting a disabled person between floors, including at least one guide rail extending substantially parallelly to a stairway, a moveable carrier frame suspended from the guide rail means including carrier roller means, and drive means of a rack and pinion type drive for displacement of the carrier frame along the guide rail, in which the vertically disposed pinion engaging the rack is provided on the lower side of the guide rail, wherein the drive means comprises a first and second set of guide rollers pivotally arranged one behind the other on each side of the pinion drive wheel in the frame. A staircase lift according to the invention is suitable for installation

on a staircase with variable slope and bends, such as a staircase with one or more intermediate plateaux with a discrete guide rail and curved portions. In a staircase lift according to the invention, a compact drive means, i.e. with a vertically oriented pinion, is provided whereby it is ensured that the pinion is kept centred in the rack in the guide rail and whereby the moveable frame is provided with sufficient stability also when entering into a bent portion, running in the bent portion and exiting the bent portion. Hereby, a satisfactory solution is provided making a side rail guided staircase lift suitable for running along a curved track in a stable and smooth manner while also offering a comfortable and smooth ride in a dignifying way for the disabled persons using the lift.

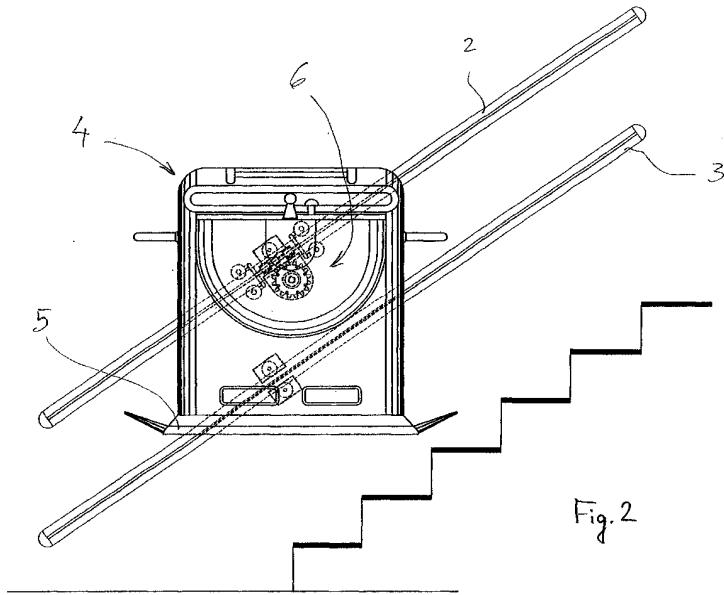


Fig. 2

## Description

**[0001]** The present invention relates to a staircase lift for transporting a disabled person between floors, including at least one guide rail extending substantially parallelly to a stairway, a moveable carrier frame suspended from the guide rail means including carrier roller means, and drive means of a rack and pinion type drive for displacement of the carrier frame along the guide rail, in which the vertically disposed pinion engaging the rack is provided on the lower side of the guide rail.

**[0002]** Staircase lifts of this kind are used to carry disabled persons in wheelchairs or elderly people between floors by means of a stairway. The staircase lift can be mounted on the sidewall or columns of stairways used both indoors and outdoors. The staircase lift includes a moveable frame displaced along a fixedly mounted guide rail on the side of the stairway. This type of staircase lift is driven by a rack and pinion drive whereby relatively steep staircases and a relatively heavy weight may be displaced in the lift. Moreover, a second support rail is provided for stability of the carrier frame during movement of the lift. The carrier frame is provided with drive means and a platform for a wheelchair. The platform may be folded up when not in use. Alternatively, the frame is provided with a foldable seat. By hanging the lift from guide rails on the side of the stairway, the entire staircase lift takes up only a small amount of space on the stairway. This is important, as access to the staircase may not be blocked.

**[0003]** In a staircase with a varying slope and/or curves, it is important to keep the carrier frame vertical in order to ensure safe and comfortable transport in the lift. Examples of staircase lifts with such solutions are known from e.g. WO95/29867 and EP-A-1 053 968. Although these solutions overcome the problem of keeping the frame in a vertical position during changes in the slope, the pinion is displaced in the engagement with the rack if the guide rail is curved. This means that these known staircase lifts are only suitable for straight stairways, as the risk of damaging the drive mechanism when entering a curved section of the stairway is too high which results in an unacceptable level of safety. The drive mechanism in a staircase lift is loaded with the entire weight of the platform which means that even slight displacements may have devastating effects.

**[0004]** In US-A-6,155,382 a running gear for a rail-guided seat is known. The seat lift is typically lighter in structure which means that the drive mechanism can be kept relatively compact in dimensions. In this solution, the pinion is positioned in a plane parallel to that of the slope of the staircase and the seat is mounted on a bridge assembly with two cardan suspensions. Hereby, the problem of curvature in the vertical plane is overcome, as the guide rail bends in the same plane as that of the pinion. However, this solution only works as long as the rack faces towards the staircase. This means that the fixed structure of the lift, i.e. the guide rail system,

takes up a lot of space and has a rough and greasy surface pointing towards the staircase whereby pieces of clothing on persons transported in the lift or other people walking on the staircase may be caught or otherwise damaged, e.g. due to oil or grease on the track or even on the steps of the stairway.

**[0005]** It is an object of the invention to provide an improved staircase lift of the initially mentioned kind which is suitable for running along a curved track in a comfortable, safe, and reliable manner and which does not take up an unacceptable amount of space in the staircase.

**[0006]** According to the present invention, a staircase lift of the initially mentioned kind is provided, wherein the drive means comprises a first and second set of guide rollers pivotally arranged one behind the other on each side of the pinion drive wheel in the frame. The invention also concerns a moveable carrier frame for a staircase lift of the type wherein the carrier frame is suspended from fixedly mounted guide rail means of the kind specified in claim 14.

**[0007]** A staircase lift according to the invention is suitable for installation in a staircase with variable slope and bends, such as a staircase with one or more intermediate plateaux comprising a discrete guide rail with curved portions. In a staircase lift according to the invention, a compact drive means, i.e. with a vertically oriented pinion, is provided which ensures that the pinion is kept centred in the rack in the guide rail and that the moveable frame is provided with sufficient stability also when entering into a bent portion, running in the bent portion and exiting the bent portion. Hereby, a satisfactory solution is provided making a side rail guided staircase lift suitable for running along a curved track in a stable and smooth manner while also offering a comfortable and smooth ride in a dignifying way for the disabled persons using the lift.

**[0008]** Preferably, the carrier roller means are arranged on opposite sides of the pinion drive wheel, said carrier roller means and drive wheel being in a traction plane substantially perpendicular to the direction of travel. Hereby, the vertical rotation axis of the carrier frame, when running along a bent portion of the guide rail, is well determined and coincides with the radial axis of symmetry of the tooth or teeth of the pinion meshed with the rack.

**[0009]** Preferably, the pivotally arranged first and second guide roller means each include a movement control lever with a first end where at least one set of idle rollers is mounted, a second end at which point the first and second movement control levers are joined to each other by a universal joint, said universal joint being substantially in the traction plane. Hereby, a compact centring and stabilising system is provided.

**[0010]** Moreover, the movement control levers are preferably pivotally mounted to the carrier frame at an equal distance from the universal joint on each side thereof. Hereby, the geometry of the movement control is similar irrespective of the direction of movement.

**[0011]** In the preferred embodiment, each set of the pivotally arranged guide roller means includes an upper and a lower set of rollers engaging the upper and lower portions of the guide rail, respectively. Hereby, the movement control levers are provided with a fork-like shape that is particularly compact. The sets of rollers ensure a centring of the frame on the rail and provide a particularly firm grip around the guide rail, as the preferably substantially tubular shaped guide rail is engaged by guide rollers on the upper and lower sides. The lower sets of rollers prevent the frame from being lifted off the rail, as the lower sets of rollers are positioned opposite that of the upper rollers. In this way, the upper and lower rollers co-operate in order to constrain the movement of the frame to movements in the directions along the guide rail. The advantage of having a guide rail with a substantially circular cross-section and a traction rack on the lowermost part of the rail is that this will also function as a natural banister with a smooth surface for the staircase. The guide rail may alternatively be formed in an elliptical, oval or other desired cross-sectional shapes.

**[0012]** Preferably, the teeth of the pinion wheel are substantially circular in the cross-section and the rack of the guide rail displays a row of correspondingly shaped circular holes. Hereby, the pinion is allowed to rotate whilst being intermeshed with the toothed rack. This results in a staircase lift that can run smoothly along tight bends, i.e. guide rails with a large curvature. Accordingly, at least one section of the guide rail may be curved in one or more planes.

**[0013]** A staircase lift according to the invention may further include a supporting guide rail mounted parallelly to the first guide rail for assisting the first guide rail in carrying the load and stabilising the load-carrying frame.

**[0014]** In a first embodiment of the invention, the carrier frame is provided with a platform adapted to accommodate a wheelchair. In this embodiment, the handicapped person may place the wheelchair on the platform, either by himself or with the assistance of an assistant, and operate the lift for being transported up or down the stairs. In a second embodiment, the carrier frame is provided with a foldable seat for aiding disabled persons or weakened persons otherwise not able to climb the stairs.

**[0015]** As an additional safety precaution, the carrier frame preferably includes a sub-frame partly encompassing the guide rail and housing the carrier rollers and the drive pinion, said sub-frame having a hooked shape. Hereby, the carrier frame is prevented from falling off the rail, even in the unlikely event that the carrier rollers and the guide rollers should collapse. The staircase lift is provided with the required control and operating system as well as an emergency safety lock of the frame to the rack. Together with the emergency safety lock, the hook-shaped sub-frame ensures that the frame will be held still, even if both the driving means and the carrying means collapse. It is realised that this feature of the in-

vention could be used in connection with other staircase lifts of the conventional type.

**[0016]** In the following, the invention is described in detail with reference to the drawings, in which:

5 Fig. 1 is a schematic perspective view of a staircase with a staircase lift according to the invention,  
 fig. 2 is a side view of a staircase lift according to the invention,  
 10 fig. 3 is a detailed side view of the drive and guiding system according to a preferred embodiment of the invention and shows when the lift is running in a straight line,  
 fig. 4 is a top view of fig. 3,  
 15 fig. 5 is a detailed side view of the drive and guiding system according to a preferred embodiment of the invention and shows when the lift is entering a curved portion,  
 fig. 6 is a top view of fig. 5,  
 20 fig. 7 is a detailed side view of the drive and guiding system according to a preferred embodiment of the invention and shows when the lift is running in a curved portion,  
 fig. 8 is a top view of fig. 7, and  
 25 fig. 9 is a cross-section front view of a sub-frame according to an embodiment of the invention.

**[0017]** In figures 1 and 2, a staircase with a staircase lift is shown. The staircase lift is mounted on the side of the stairway, on a side wall or a separate frame structure. The staircase lift includes a fixed part and a moveable part. The fixed part comprises a first guide rail 2 and a second guide rail 3. The two guide rails 2, 3 are mounted in parallel with one above the other on the side.

30 35 The guide rails 2, 3, or at least the first guide rail 2, is/are made of a tubular profile that functions as a banister for the stairway. As shown in the figure, the guide rails 2, 3 follow the staircase as it changes direction. This results in a bent or curved portion 2a of the guide rail 2, 3. This curvature may be a result of a change in slope of the staircase and/or a change in direction, i.e. the curvature may be in a horizontal or a vertical direction or both. The first guide rail 2, i.e. the top one, is provided with a rack for a geared engagement with driving means 40 45 6 of a moveable carrier frame 4 displaced along the guide rails 2, 3 as a kind of shuttle-skate. The second guide rail 3 functions as a support for the moveable frame 4 displaced along the guide rails 2, 3.

**[0018]** The moveable frame 4 includes a platform 5 for accommodating a disabled person in a wheelchair. Alternatively, or in addition to the platform 5, a foldable seat may be provided for an assistant to the person in the wheelchair or for transporting an elderly or otherwise weakened person up or down the staircase.

**[0019]** In figures 3 and 4, the details of the drive means are shown. The shuttling moveable frame 4 is driven along the guide rail 2 by a rack and pinion type drive, where the frame 4 is self-propelled as the pinion

7 is driven by an electric motor powered by a rechargeable battery package (not shown).

**[0020]** The pinion 7 engages the rack 20 on the underside of the guide rail 2 (see cross-section of the guide rail in fig. 9). On the upper side of the guide rail 2, a carrier roller set 8 is positioned opposite the pinion 7. The carrier rollers 8 rest on the guide rail 2 and carry the weight of the frame and its load - possibly together with cooperating carrier rollers engaging the lower second guide rail 3.

**[0021]** The pinion wheel 7 and the carrier rollers 8 are accommodated in a sub-frame 9 to which the rest of the moveable frame 4 is pivotally mounted.

**[0022]** A first and second set of guide rollers 10, 11 and 12, 13, respectively, are arranged on each side of the carrier rollers 8. The guide rollers are mounted on movement control levers 14 and 15. Each of the movement control levers 14 and 15 are fork-like in shape and carry an upper set of guide rollers 10, 12 and a lower set of guide rollers 11, 13 on each of the fork-fingers. The levers 14, 15 are joined together by a universal joint 18 positioned substantially in the central plane of the set of carrier rollers 8 and the pinion 7. The levers 14 and 15 are pivotally mounted to the sub-frame in swivel joint bearings 16 and 17, respectively. The levers are provided with a certain length so that the guide rollers 10, 11 of the first movement lever 15 and the rollers 11, 12 of the second lever 14 are disposed at a suitable distance from the carrier rollers and the pinion arranged in the middle of the drive means 6.

**[0023]** As shown in the top view in figure 4, the sets of rollers include two rollers that engage with opposite sides of the guide rail 2. In figure 4, the rollers 8a, 8b, 10a, 10b, 12a, 12b are formed in a conic shape for making contract with a tubular guide rail 2 with a substantially circular cross-section. It is realised by the invention, of course, that the rollers may be provided in any suitable form in order to ensure precise and stable contact with the guide rail. The advantage of having two side rollers in each set is that the rollers ensure that the drive system is centred on the guide rail 2, and in particular that the pinion wheel 7 is centred in the rack 20 (see fig. 9).

**[0024]** As can be seen in fig. 4, the movement control levers 14 and 15 are bent out of the centring plane and mounted to the sub-frame 9 in a plane parallel to the centring plane at a certain distance between the two parallel planes. In this plane, the universal joint 18 is also disposed.

**[0025]** In this configuration, the first set of guide rollers 10, 11, the carrier rollers and the driving pinion wheel 7 and the second set of guide rollers 12, 13 are linked to each other in such a way that the sub-frame, and thereby the pinion and the set of carrier rollers 8, is automatically placed with an inclination corresponding to the tangential orientation of the section of the track in which it is present due to the linkage between the sets of guide rollers 10, 11; 12, 13 in front of and behind the drive pinion 7.

**[0026]** In figs. 5 and 6, a drive system according to the invention is shown in action. In this situation, the guide rail 2 is bent, e.g. due to a change in slope of the staircase. The first set of guide rollers 10, 11 is lifted upwards, causing the universal joint 18 downwards due to the movement control lever 15 which is pivotally mounted in the swivel joint 16. When the universal joint 18 is moved out of its initial position (the initial position being its "straight line" position, as shown in figs. 3 and 4), the second movement control lever 14 is loaded. However,

5 since the trailing, second guide rollers 12, 13 of the second lever 14 are in contact with the guide rail 2, the second swivel joint 17, over which the second movement control lever 14 is pivotally mounted to the sub-frame 9, 15 is forced downwards causing the entire sub-frame 9 to rotate slightly, including the carrier rollers 8 and the pinion wheel 7. In this way, the pinion wheel is kept in an intermeshing engagement with the rack 20 on the underside of the rail 2.

**[0027]** In figs. 7 and 8, a similar situation of movement is illustrated in relation to a turn, e.g. as the staircase lift is mounted in a swinging staircase, or the guide rail 2 follows a corner of a staircase. In this situation, the first set of rollers 10 is moved sideways towards the direction 20 of the turn, e.g. to the left, causing the first movement control lever 15 to pivot in the swivel joint 16 and move the universal joint 18 outwards in the turn which forces the second movement control lever 14 to move the sub-frame 9 outwards due to the swivel joint connection of the second movement lever 14 to the sub-frame 9. Hereby, the tooth or teeth 7a of the pinion 7 engaging the rack is/are kept in alignment in the rack 20, also during a change in the direction of travel of the frame.

**[0028]** The components of the drive means 6 are preferably mirrored so that the geometry and the physical characteristics of their movement are the same irrespective of the direction of movement of the moveable frame in the staircase lift.

**[0029]** In the preferred embodiment of the invention, 40 the pinion wheel is provided with teeth 7a shaped in the geometrically correct curved form in the radial direction of the pinion 7, but provided with a circular cross-section. Correspondingly, the rack 20 is formed as a row of 45 circular holes, preferably in a nylon or similar polymeric material, extending along the underside of the guide rail. The pinion is preferably made of steel. Since the guide rail is intended for use as a banister, the persons using the banister of the staircase will inevitably come into contact with the rack as they support themselves by 50 means of the banister. By using a polymer-based material for the rack, the necessity for lubrication of the drive system is avoided which is advantageous as this, in turn, means that no grease or oil is deposited or present on the guide rail rack.

**[0030]** As can be seen in figure 9, the sub-frame 9 is preferably designed with a hook-like shape so that the frame 4 is prevented from falling off the guide rail 2 in the event of breakage of the carrier rollers 8. This safety

measure, together with other safety precautions such as a safety lock of the pinion in the rack, makes a staircase lift according to this embodiment of the invention particularly advantageous from a safety point of view.

**[0031]** By the invention, it is realised that the hook-shaped sub-frame 9 may also be used on staircase lifts with other drive systems if deemed appropriate.

**[0032]** In the description of the invention, terms like horizontal and vertical are used for the explanation of the invention. However, it is realised by the invention that these terms should merely be understood as relative terms and that an entire drive mechanism and staircase lift according to the invention may be rotated in any direction without departing from the scope of the invention, as such solutions and other solutions making use of the general idea behind the invention are considered to be solutions equivalent to solutions according to the invention as set forth in the accompanying claims.

### Claims

1. A staircase lift for transporting a disabled person between floors, including at least one guide rail extending substantially parallelly to a stairway,

a moveable carrier frame suspended from the guide rail means including carrier roller means, and  
drive means of a rack and pinion type drive for displacement of the carrier frame along the guide rail, in which the vertically disposed pinion engaging the rack is provided on the lower side of the guide rail,

#### characterised in that

the drive means comprises a first and second set of guide rollers pivotally arranged one behind the other on each side of the pinion drive wheel in the frame.

2. A staircase lift according to claim 1, wherein the carrier roller means are arranged on opposite sides of the pinion drive wheel, said carrier roller means and drive wheel being in a traction plane substantially perpendicular to that of the direction of travel.

3. A staircase lift according to claim 1 or 2, wherein the pivotally arranged first and second guide roller means each include a movement control lever with a first end where at least one set of idle rollers are mounted, a second end at which point the first and second movement control levers are joined to each other by a universal joint, said universal joint being substantially in the traction plane.

4. A staircase lift according to claim 3, wherein the movement control levers are pivotally mounted to

the carrier frame at an equal distance from the universal joint on each side thereof.

5. A staircase lift according to claim 3 or 4, wherein each set of the pivotally arranged guide roller means includes an upper and a lower set of rollers engaging the upper and lower portions of the guide rail, respectively.

10 6. A staircase lift according to any of the preceding claims, wherein the carrier roller means and the first and second set of rollers each comprise a guide roller engaging each side of the guide rail.

15 7. A staircase lift according to any of the preceding claims, wherein the teeth of the pinion wheel are substantially circular in the cross-section and the rack of the guide rail displays a row of correspondingly shaped circular holes.

20 8. A staircase lift according to any of the preceding claims, wherein at least one section of the guide rail is curved in one or more planes.

25 9. A staircase lift according to any of the preceding claims, wherein the guide rail is substantially circular in the cross-sectional shape.

30 10. A staircase lift according to any of the preceding claims, wherein the staircase lift further includes a supporting guide rail mounted parallelly to the first guide rail.

35 11. A staircase lift according to any of the preceding claims, wherein the carrier frame is provided with a platform adapted to accommodate a wheelchair.

40 12. A staircase lift according to any of the preceding claims, wherein the carrier frame is provided with a foldable seat.

45 13. A staircase lift according to any of the preceding claims, wherein the carrier frame includes a sub-frame partly encompassing the guide rail and housing the carrier rollers and the drive pinion, said sub-frame having a hooked shape.

50 14. A moveable carrier frame for a staircase lift of the type wherein the carrier frame is suspended from fixedly mounted guide rail means, said carrier frame including a platform for accommodating a wheelchair, a seated person or the like, drive means of a rack and pinion type drive including a pinion for displacement of the carrier frame along the corresponding rack of guide rail,

#### characterised in that

the drive means comprises a first and second set of guide rollers pivotally arranged one behind the

other on each side of the pinion drive wheel in the frame.

15. A carrier frame for a staircase lift according to claim 14, wherein the carrier roller means are arranged on opposite sides of the pinion drive wheel, said roller means and drive wheel being in a traction plane substantially perpendicular to the direction of travel. 5

16. A carrier frame for a staircase lift according to claim 14 or 15, wherein the pivotally arranged first and second guide roller means each include a movement control lever with a first end where at least one set of idle rollers is mounted, a second end at which point the first and second movement control levers are joined to each other by a universal joint, said universal joint being substantially in the plane of the traction plane. 10 15

17. A carrier frame for a staircase lift according to claim 16, wherein the movement control levers are pivotally mounted to the carrier frame at an equal distance from the universal joint on each side thereof. 20

18. A carrier frame for a staircase lift according to claim 16 or 17, wherein each set of the pivotally arranged guide roller means includes an upper and a lower set of rollers engaging the upper and lower portions of the guide rail, respectively. 25 30

19. A carrier frame for a staircase lift according to any of claims 14 to 18, wherein the carrier roller means and the first and second set of rollers each comprise a guide roller engaging each side of the guide rail. 35

20. A carrier frame for a staircase lift according to any of claims 14 to 19, wherein the teeth of the pinion wheel are substantially circular in the cross-section and the rack of the guide rail displays a row of correspondingly shaped circular holes. 40

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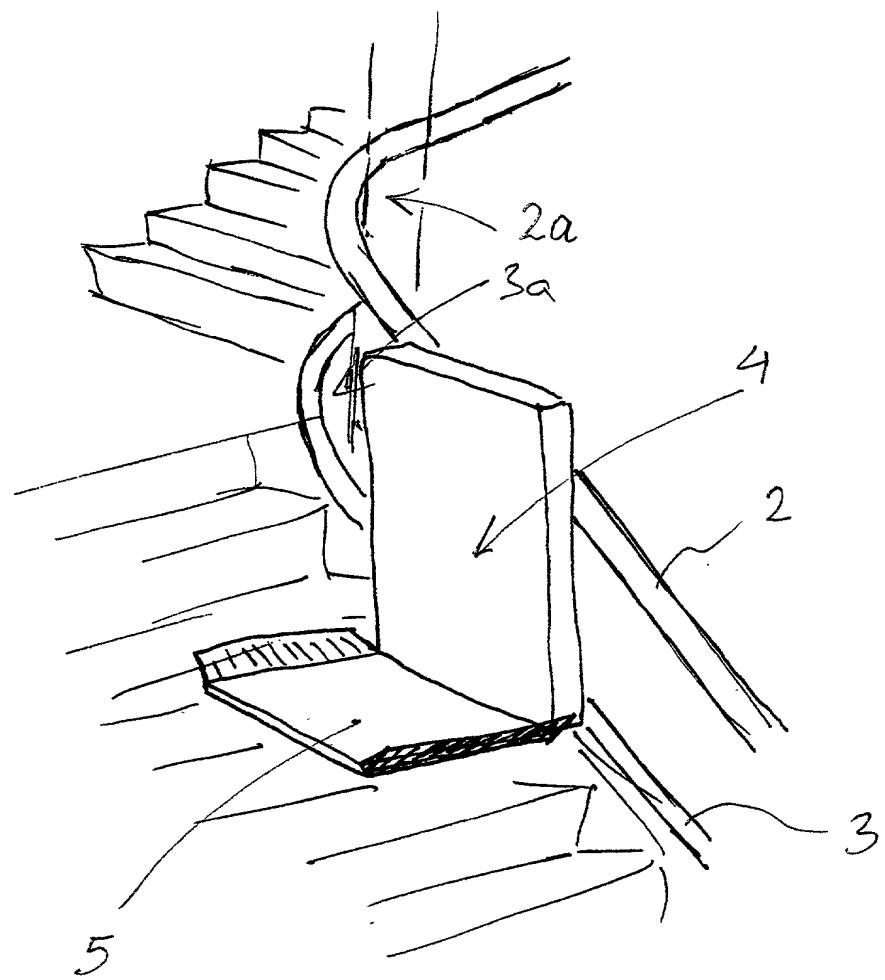
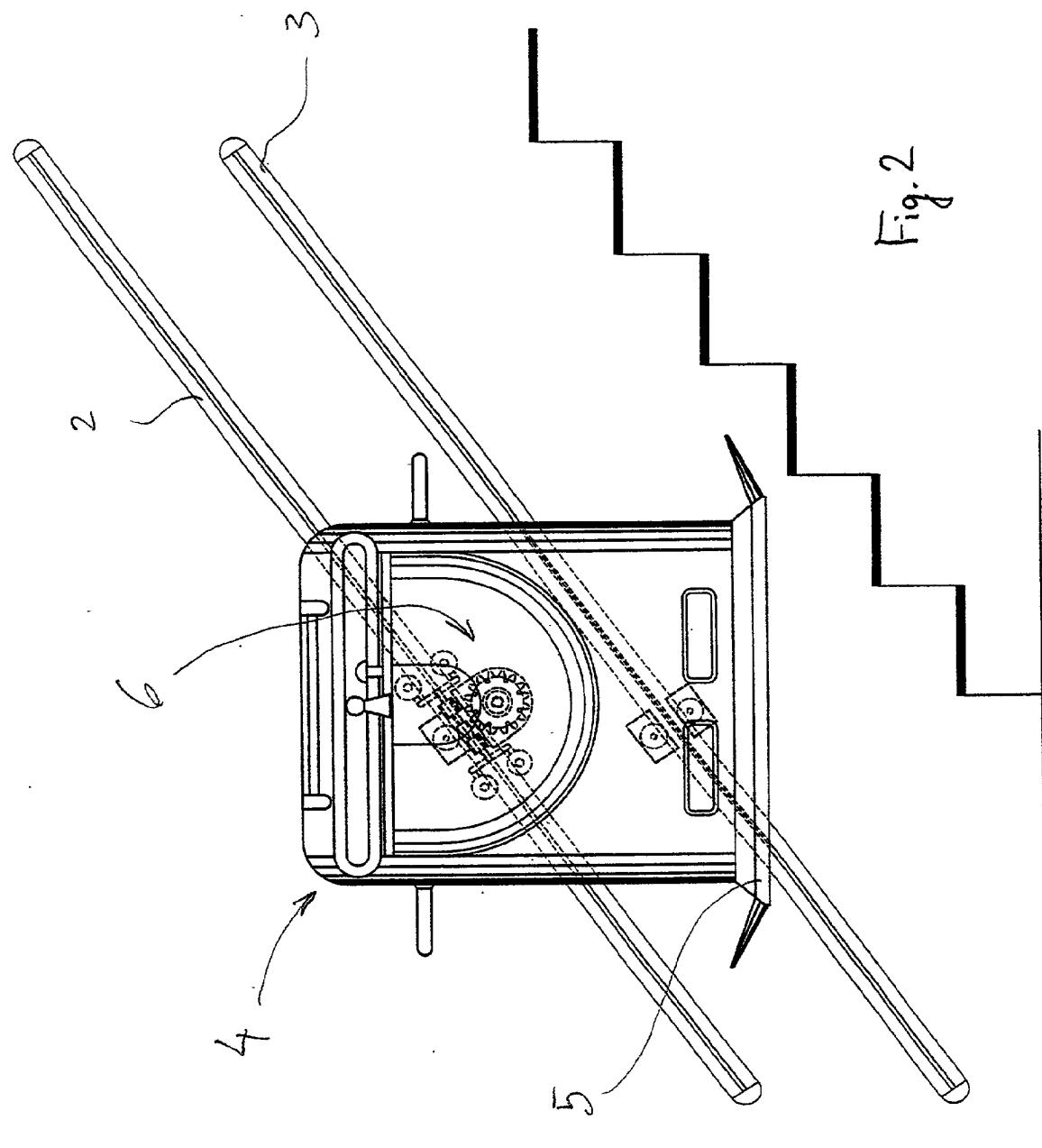


Fig. 1



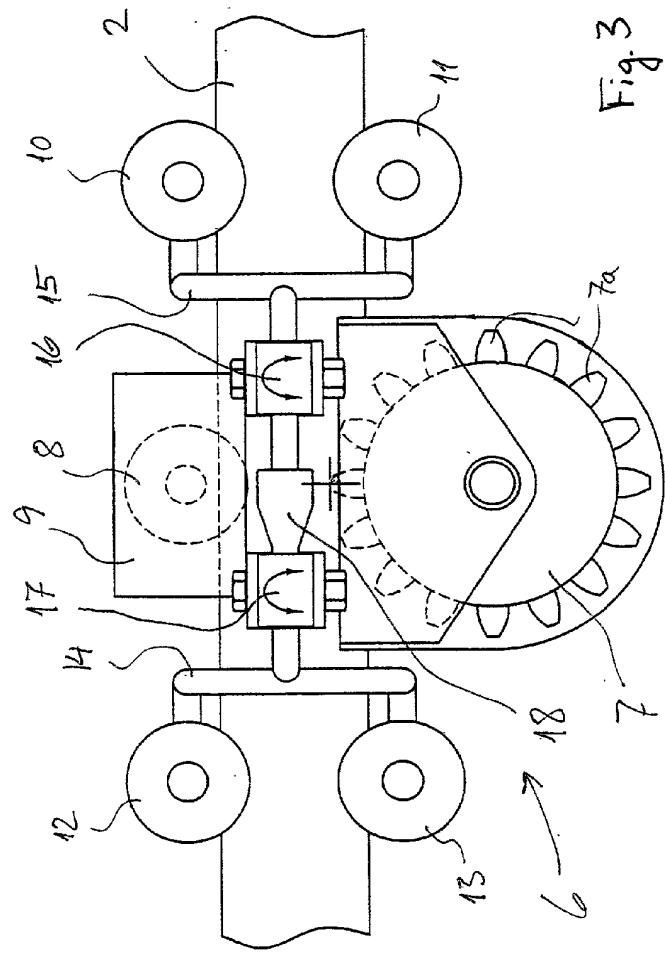


Fig. 3

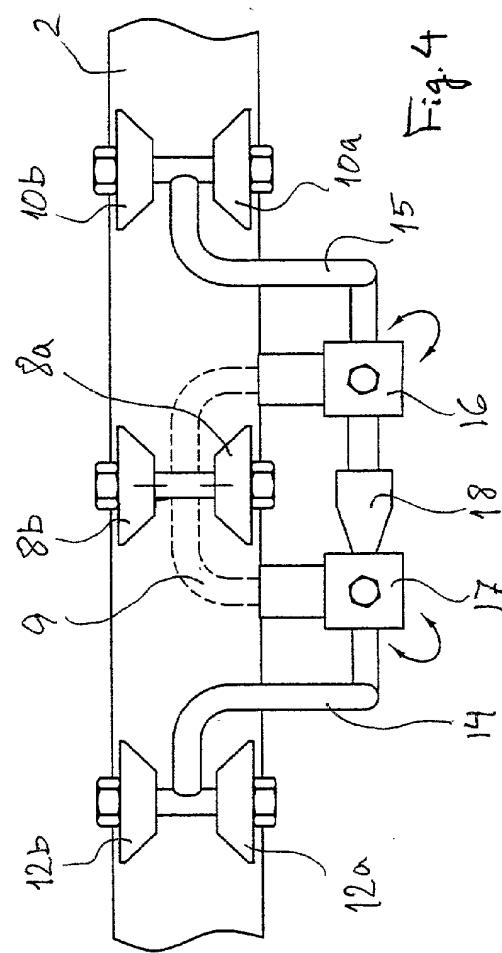
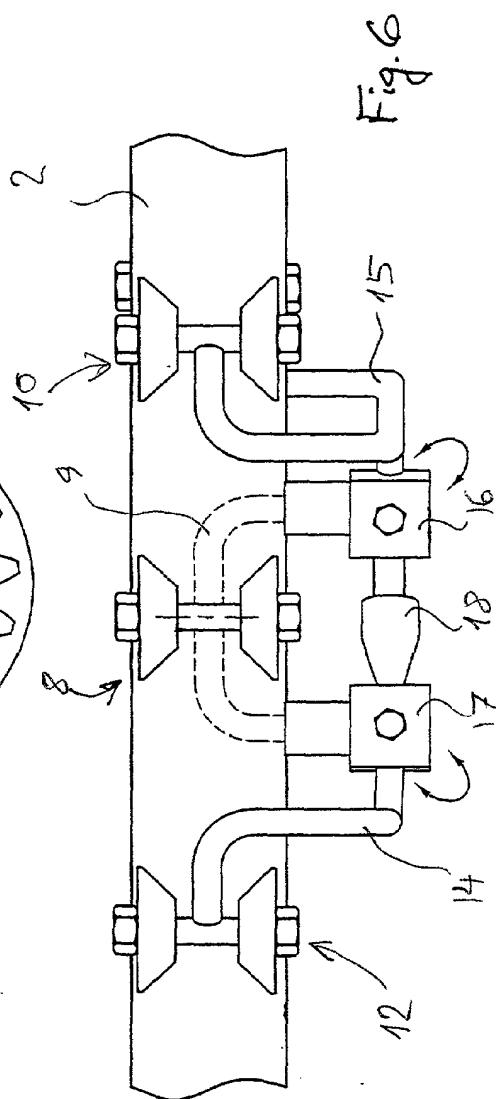
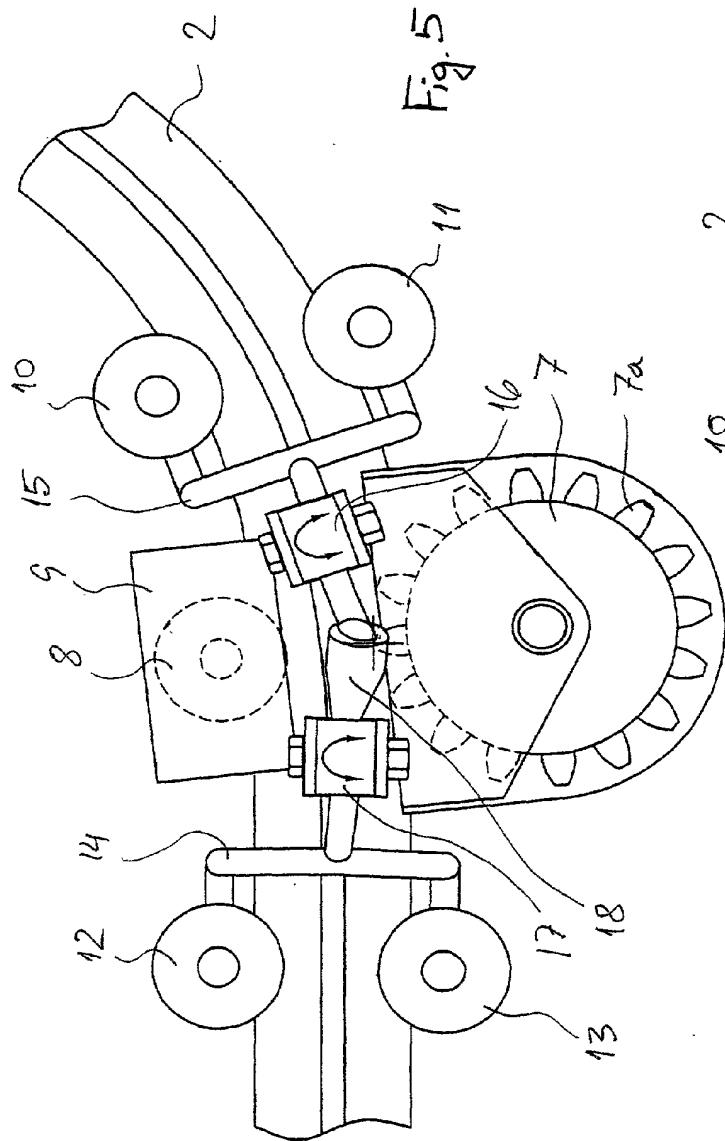
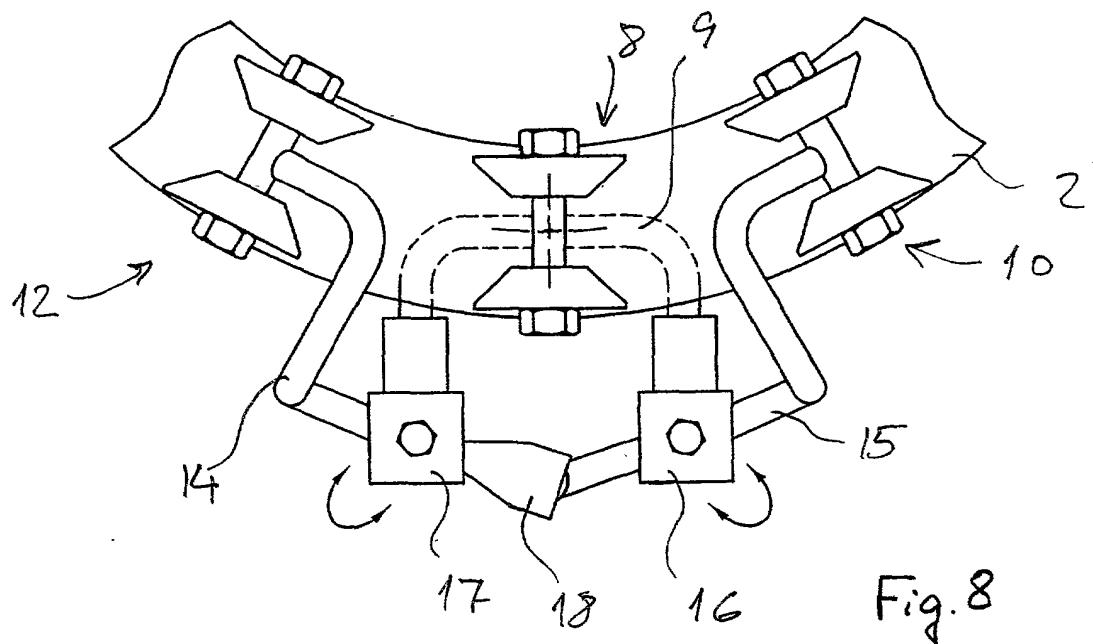
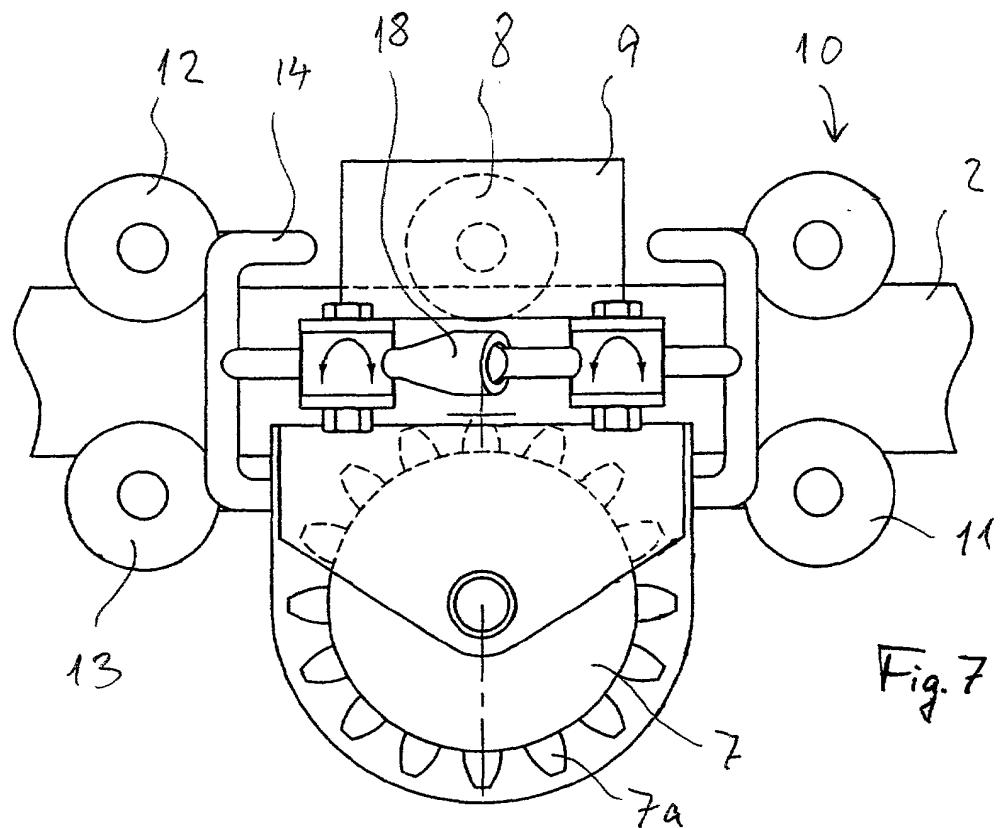


Fig. 4





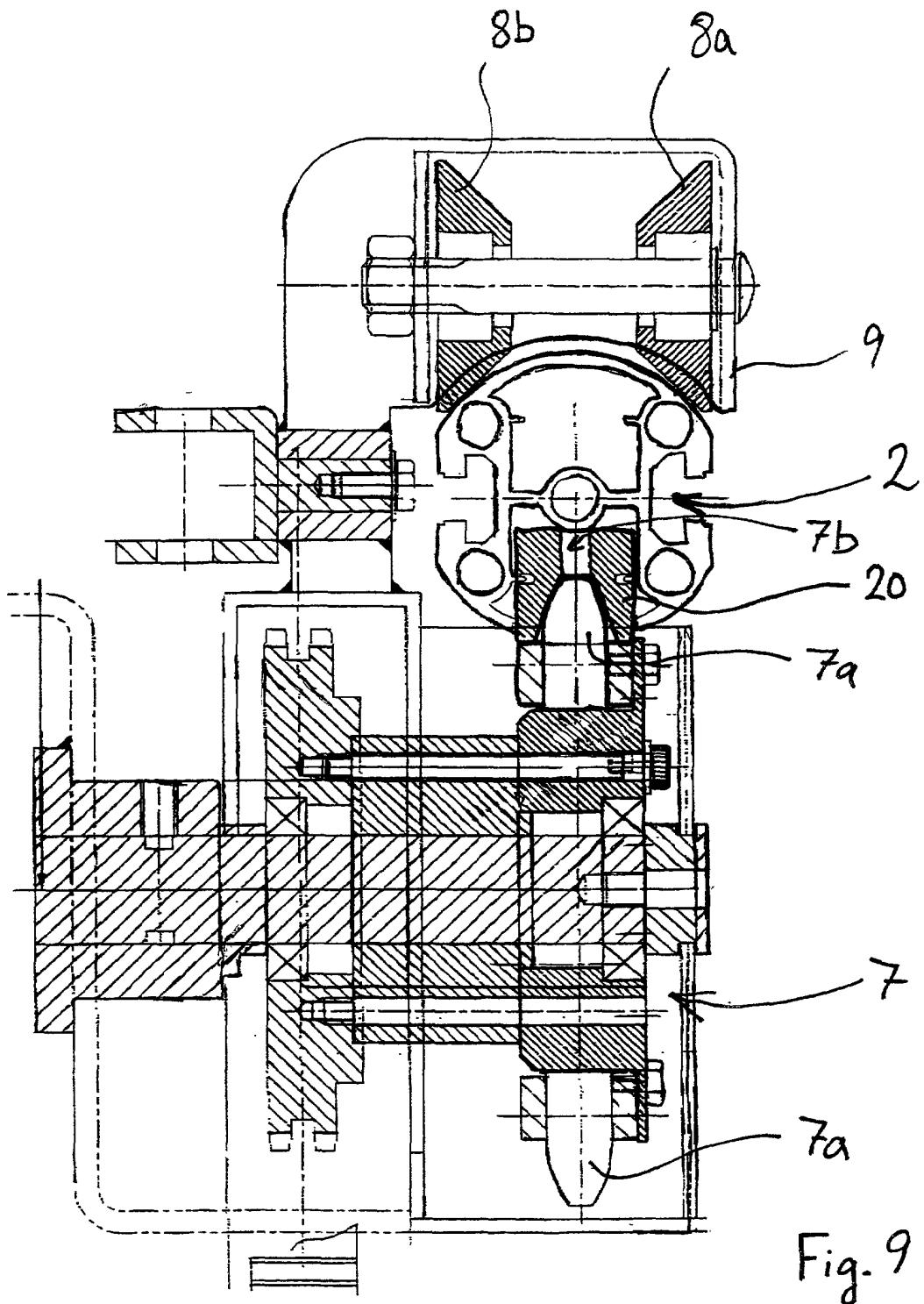


Fig. 9



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Application Number  
EP 01 20 0767

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	* abstract; figures 1,10,11,13 * * page 1, paragraph 1 * * page 3, line 2 - line 5 * * page 3, line 23 - line 26 * * page 10, line 21 - line 25 * -----	14	
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The present search report has been drawn up for all claims			
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THE HAGUE	26 July 2001		Nelis, Y
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EP 01 20 0767

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